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Sense of coherence and substance use: Examining mutual influences

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Abstract:
Sense of coherence (SOC) is conceptualized as a mutable orientation to life, but has often been found a stable attribute of individual differences. While several studies have documented the relationship between SOC and substance use, nothing is known about mutual influences between both variables over time in adolescence. The present study examines whether changes in SOC predict changes in substance use, or whether changes in substance use predict changes in SOC. A longitudinal cross-lagged panel design was used to inspect SOC and self-reported frequency of substance use of tobacco, alcohol, and cannabis over the course of ten years. Participants were 318 German adolescents aged 14–15 at the beginning of the study. Structural equation modeling indicated a single significant negative path from SOC to later cannabis use as well as one significant positive path from cannabis use to SOC. Despite a general association – high SOC corresponds to less substance use – SOC overall develops independently from substance use.

Keywords: Sense of coherence, Alcohol. Tobacco, Cannabis, Cross-lagged, Longitudinal

1. Introduction

Sense of coherence (SOC) is the core aspect of Antonovsky's salutogenic theory and is conceptualized as a general resistance resource that promotes health (Antonovsky, 1987, 1998). In this theory, health is not understood merely as an on/off state, but as a continuum between health and disease. A stronger SOC should enable people to move towards the health-end of this continuum.

According to Antonovsky, SOC represents a general "orientation-to-life". It protects people's health in the face of adversities like critical life events and stress. Theoretically, three major factors constitute SOC: comprehensibility, that is, an individual's perception that situations and events are structured and clear; manageability, that is, an individual's belief that she has the necessary skills to deal with the challenges of life; and meaningfulness, that is, an individual's belief that the demands and challenges of life are worthy of investment and engagement.

The positive influence of a SOC has been described numerous times. For example, SOC has been linked to positive mental health and health-related behavioral outcomes (Eriksson & Lindström, 2006; Togari, Yamazaki, Takayama, Yamaki, & Nakayama, 2008), general psychological well-being (Nilsson, Leppert, Simonsson, & Starrin, 2010), depression (Haukkala et al., 2013), and anxiety (Moksnes, Espnes, & Haugan, 2013). SOC has also received increasing attention regarding the development of adolescent health issues (Rivera, García-Moya, Moreno, & Ramos, 2013). Concerning substance use, high SOC was shown to predict reduced tobacco use and lesser consumption of alcohol (Mattila et al., 2011) as well as less alcohol-related behavioral problems (Nilsson, Starrin, Simonsson, & Leppert, 2007). This is especially important, as early and high-frequent consumption has been associated with the development of later problematic consumption styles (Behrendt, Wittchen, Höfler, Lieb, & Beesdo, 2009).

Antonovsky (1987) described the development of SOC as a dynamic process up to the age of 30 that is supposedly influenced by external factors. Adolescence is seen as a particularly important developmental phase for the development of SOC, and SOC is expected to be mutable and fluctuant at this age. As such, SOC can be seen as part of an individual's ontogenesis characterized by several developmental tasks (Havighurst, 1972; Hurrelmann & Quenzel, 2012). It has been documented that the use of psychoactive substances is an important aspect of adolescent health behavior (Silbereisen, Noack, & Reitzle, 1987; Young et al., 2002) and, as such, could also be considered a developmental task, for instance, an individual's quest for autonomy from the (adult or peer) mainstream, achieving peer-group acceptance, or the development of coping strategies (Hurrelmann & Quenzel, 2012). SOC might either be a protective factor for these tasks, yet it might as well be the result of successful coping.

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The mutability and flexibility of SOC has received increasing attention in recent years. Several studies have documented a surprising stability of SOC and a high test-retest reliability in adulthood (Feldt, Leskinen, Kinnunen, & Mauno, 2000; Feldt, Leskinen, Kinnunen, & Ruoppila, 2003). In younger ages, SOC has also been shown to be rather stable, even through adolescence (Honkinen et al., 2008). Similarly, SOC has been found not only to be a predictor, but also an outcome of health. Longitudinally, psychological symptoms at the age of three (as reported by parents) predicted lower SOC scores 15 years later at age 18 (Honkinen et al., 2009). Theoretically, this association is astonishing, but it is not possible to control for the level of SOC at such an early age. Contrasting these results on stability, SOC has been shown to increase after positive life events, such as recovery from major depression (Skärsäter et al., 2009), social intervention for unemployed people (Vastamäki, Moser, & Paul, 2009), therapeutic intervention (Weissbecker et al., 2002), and even after clinical rehabilitation from cannabis abuse (Lundqvist, 1995). Consequently, SOC has been shown to decrease after negative life events (Lövheim, Graneheim, Jonsén, Strandberg, & Lundman, 2013).

Given the astounding documented mutability of SOC, the following research aims to examine mutual influences between SOC and substance use of tobacco, alcohol, and cannabis. While the importance of SOC regarding substance use has been documented before, no study has focused on mutual influences, that is, whether a change in one variable can predict a change in the other variable at a later time. If SOC were truly flexible and considerably developed during adolescence and early adulthood, one would expect an increase in health-benefitting behavior: less substance use as SOC increases. Similarly, if SOC depended on experiences made during adolescence (in this case with psychoactive substances), we would expect SOC to be predicted over time by previous levels of substance use. To answer this question rigorously, a cross-lagged panel design (structural equation modeling) is required.

2. Methods

2.1. Study sample

The following research is part of a ten-year-longitudinal study of drug use patterns (RISA)[1] conducted in the south of Germany from 2003 to 2012. The study comprised 14 data collection events. Participants were 318 students (164 female; 51.6% and 154 male; 48.4%) with a mean age of 14 at the beginning of the study. 65.4% of the participants (n = 208) grew up in a traditional family, which was defined as living with both biological parents up to the age of 18 years. Level of education was also balanced across the three-tier German school system.

While there was noticeable sample attrition (n = 134; 42.1%) over the course of ten years, participant dropout was comparable to other studies on adolescents' development (Honkinen et al., 2009). There were some signs of systematic dropout. In comparison to participants remaining in the study until the end, those who dropped out consumed moderately more tobacco at age 14–15, Ms = 3.59 vs. 2.70 (SDs = 2.49 vs. 2.11), $t(248.14) = 3.30$, $p = .001$, Cohen's $d = 0.39$, and more cannabis, Ms = 1.49 vs. 1.26 (SDs = 1.00 vs. 0.70), $t(214.03) = 2.27$, $p = .024$, $d = 0.27$.

2.2. Measures

2.2.1. SOC-13: Sense of coherence

SOC was measured using an abbreviated German 13-item adaptation of Antonovsky's original Orientation to Life questionnaire with five-point rating scales (most of the time ranging from 0 = very rarely to 4 = very often) (Abel, Kohlmann, & Noack, 1995). For comparability with a later authorative German version developed by Schumacher and colleagues (Schumacher, Gunzelmann, & Brähler, 2000), scores were rescaled to a seven-point rating scale format using a linear transformation.[2] The scale includes four meaningfulness items (e.g., *"Do you have the feeling that you don't really care about what goes on around you?"*), five comprehensibility items (e.g., *"Has it happened in the past that you were surprised by the behavior of people whom you thought you knew well?"*) and four manageability items (e.g., *"Has it happened that people whom you counted on disappointed you?"*). Replicating the three-factor structure of the SOC scale has been empirically challenging (Klepp, Mastekaasa, Sørensen, Sandanger, & Kleiner, 2007; Zimprich, Allemand, & Hornung, 2006). As Antonovsky (1987) stressed the holistic nature of the SOC scale and recommended not to use subscale scores, a sum score is commonly used. In our sample, Cronbach's Alpha of the scale increased from .80 to .92 over the course of ten years.

2.2.2. Substance use frequency

The substance use scale was adapted from the national survey on drug use among adolescents (BZgA, 2004). It is similar to the brief self-report drug use frequency measure provided by O'Farrell, Fals-Stewart and Murphy (2003). 6-month-substance use frequency was measured using a single item question: *"How often have you used this substance in the last 6 months?"* Answers were given separately for tobacco, alcohol, and cannabis on seven-point scales with the following options: (1) *"not used in last 6 months"*, (2) *"1–2 times in the last 6 months"*, (3) *"3–5 times in the last 6 months"*, (4) *"1–3 times a month"*, (5) *"1–2 times a week"*, (6) *"several times a week"*, and (7) *"several times a day"*.

2.3. Statistical analysis

We used SPSS 21 for descriptive data analyses and Mplus 5.21 (Muthén & Muthén, 1998–2007) for Structural Equation Modeling (SEM). With SEM (Kline, 2011) multiple relationships among several variables in a model can be inspected concurrently. Specifically, the cross-lagged panel design allows to model unique predictive influence across time. It estimates the associations and mutual influences among the variables. Hence it allows estimating the development of psychological factors over time while controlling for interindividual differences in previous behavior. The main focus is on the diagonal (longitudinal) paths from one type of variable to another type of variable at the next time point. Vertical (cross-sectional) paths between variables, and horizontal (autocorrelative longitudinal) paths within a variable are merely used for controlling statistical covariation. Yet, the diagonal, cross-lagged paths represent partial regressions that indicate the unique predictive influence of a variable at a given time.

SEM involves the estimation of variances of variables as well as of covariances between variables (Kline, 2011). This approach usually requires larger samples as the number of variables included in a model increases. Due to sample attrition after ten years, we had to reduce the number of model parameters to be estimated and therefore aggregated data over time by computing mean scores. The RISA study included 14 data collection events. In the first four cases we aggregated three data collection events to single data points (T0, T1, T2, T3), whereas the last data point (T4) comprised only two data collection events. The five data points over the course of the ten-year study represented age 14–15 (T0), age

[1] The study was approved by the ethics committee of the University Hospital Heidelberg (No. 218/2005).

[2] The rescaled values resemble the norms published by Schumacher et al. (2000) who reported a SOC sum score of M = 67.31 (SD = 12.09) for men and M = 64.52 (SD = 11.61) for women spanning a wider age range from 18 to 40.

16–17 (T1), age 18–19 (T2), age 20–22 (T3), and age 23–24 (T4). We included cross-sectional covariation between SOC and substance use at the beginning and at the end of the study to control for covariation between both types of variables. For the longitudinal aspect, we regressed every type of variable at a given point in time on the same type of variable at the preceding point in time (autocorrelations). The models also include covaration paths with gender and family setting for both, substance use and SOC, at the first data point to control for covariates.

The goodness-of-fit of the models was evaluated by (1) the—ideally non-significant—χ^2 test (Bentler & Bonett, 1980) and as low as possible a χ^2/df ratio, ideally as low as 2 (Tabachnick & Fidell, 2007); (2) the comparative fit index (CFI) with values of .90/.95 and above indicating appropriate/good model fit (Bentler, 1990; Hu & Bentler, 1999); (3) the root mean square error of approximation (RMSEA) with values of .00–.05/.06–.08/.09–.10 indicating good/reasonable/poor model fit (Browne & Cudeck, 1993); and (4) the standardized root mean square residual (SRMR) with values less than .08 considered to reflect good fit (Hu & Bentler, 1999). A robust Maximum Likelihood (MLR) algorithm was used for parameter estimation and imputation of missing data (a total of 25% of all cells across all variables and time points over the whole 10-year span).

3. Results

3.1. Descriptive data analysis

Several ANOVAs with a five-level repeated measurement factor (time) were conducted to analyze longitudinal shifts of variable means. Mauchly's test indicated that the assumption of sphericity had been violated for all ANOVAs. Consequently, Greenhouse-Geisser corrected degrees of freedom will be reported. Similar to prior studies (Young et al., 2002), substance use increased significantly from T0 to T4 for tobacco, $F(2.47,317.98) = 14.85$, $p < .001$, $\eta^2 = .10$ (*Ms* = 2.63, 2.89, 3.42, 3.53, 3.65), alcohol, $F(2.97,454.29) = 73.53$, $p < .001$, $\eta^2 = .02$ (*Ms* = 2.57, 3.40, 3.87, 3.91, 3.93), and cannabis, $F(3.14,314.44) = 6.86$, $p < .001$, $\eta^2 = .33$ (*Ms* = 1.20, 1.30, 1.53, 1.63, 1.62). Additionally, there was also a marginally significant increase in SOC from T0 to T4, $F(2.34,370.22) = 2.67$, $p = .062$, $\eta^2 = .02$ (*Ms* = 63.65, 64.24, 65.37, 64.61, 65.88).

Gender differences were evident. Men tended to consume more alcohol and cannabis. Concerning SOC, male adolescents scored significantly higher than female participants at the beginning of the study, but this difference did not subsequently retain significance. Means for SOC and substance use frequency can be seen in Fig. 1.

Individual differences in SOC appeared to be moderately stable during adolescence. From T0 to T4, autocorrelations amounted to $r(190) = .46$, $p < .001$. This means that SOC was descriptively less stable than tobacco use, which correlated from T0 to T4 at $r(167) = .54$, $p < .001$, but more stable than alcohol use, $r(182) = .32$, $p < .001$, and cannabis use, $r(141) = .42$, $p < .001$, respectively. As such, the relative stability of SOC scores among people at a young age, despite statistically significant developmental shifts of means of the sample, was remarkable, but not overwhelming. There was still sufficient variability in SOC left to be explained by the influence of developmental tasks such as handling one's substance use.

3.2. Structural equation modeling (SEM)

3.2.1. Tobacco

Figure 2 shows the standardized estimates of the SEM paths for SOC and tobacco consumption. The model fitted the data well, $\chi^2(24) = 45.87$, $\chi^2/df = 1.91$, $p < .01$, RMSEA = .054, CFI = .981, SRMR = .032. Differences in individuals' consumption and SOC scores were quite stable over time. SOC correlated negatively (cross-sectionally) at T0 and T4. The path from tobacco use at T2 to SOC at T3 turned marginally significant. No other paths were significant.

3.2.2. Alcohol

Figure 3 displays the standardized paths for SOC and alcohol. This model also fitted the data well, $\chi^2(24) = 46.95$, $\chi^2/df = 2.08$, $p < .01$, RMSEA = .055, CFI = .974, SRMR = .040. Again, the stability of SOC and alcohol use is evident. SOC had a significant negative correlation at T0, replicating Mattila and colleagues' (2011) as well as Nilsson and colleagues' (2007) cross-sectional findings. No other paths were significant.

3.2.3. Cannabis

The standardized paths for cannabis consumption and SOC are found in Fig. 4. The model also fitted the data well, $\chi^2(24) = 61.90$, $\chi^2/df = 2.58$, $p < .001$, RMSEA = .070, CFI = .953, SRMR = .057. Again, SOC and cannabis use were relatively stable. Compared to

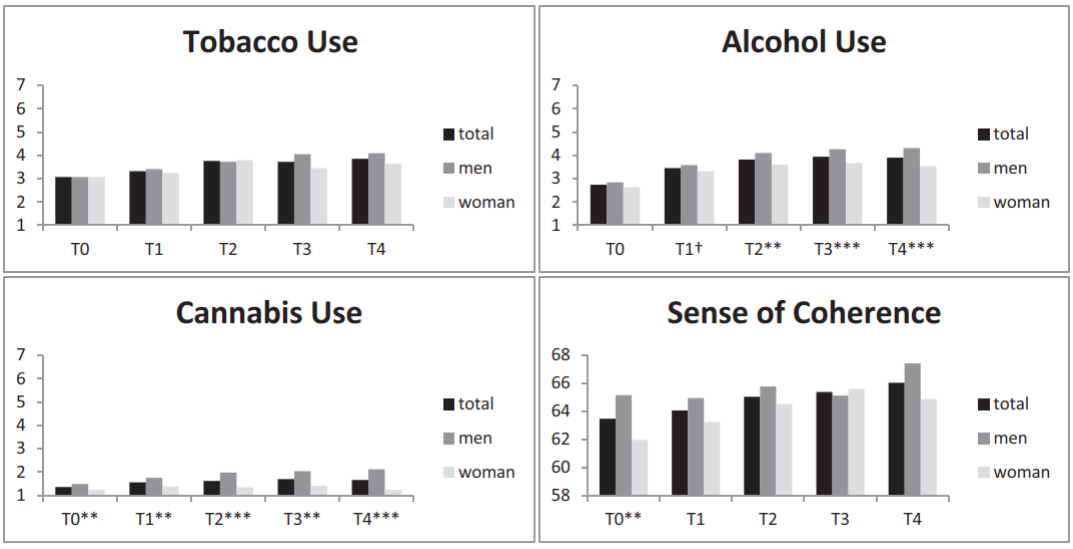

Fig. 1. Means for study variables at T0 (age 14–15), T1 (age 16–17), T2 (age 18–19), T3 (age 20–22) and T4 (age 23–24). Men and women differ significantly at $^{\dagger}p < 0.10$, *p < 0.05, **p < .01, ***p < .001 (two-tailed).

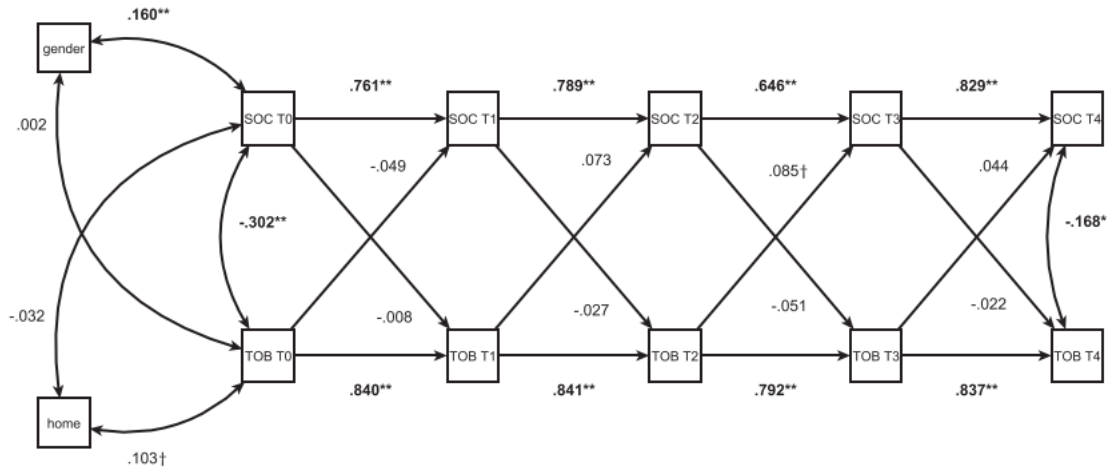

Fig. 2. Cross-lagged panel design for sense of coherence (SOC) and tobacco use frequency (TOB) with covariates gender and home (traditional family setting). Paths are significant at $^{\dagger}p < .10$, *p < .05 and **p < .01 (two-tailed).

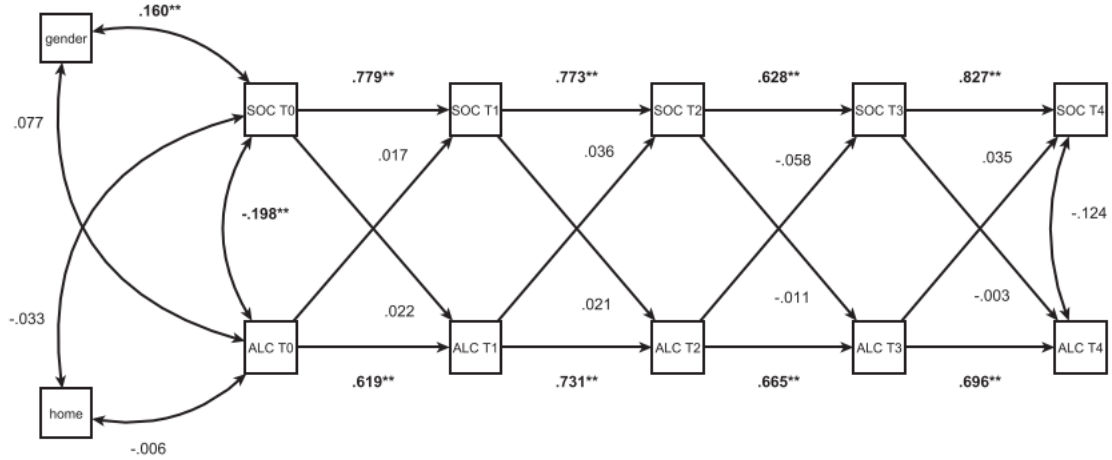

Fig. 3. Cross-lagged panel design for sense of coherence (SOC) and alcohol use frequency (ALC) with covariates gender and home (traditional family setting). Paths are significant at *p < .05 and **p < .01 (two-tailed).

the other substances, this model revealed most mutual influences. There was a significant negative cross-sectional correlation at T0. Yet, future Cannabis use at T1 was significantly reduced by high SOC scores at baseline, even when controlling for prior substance use. Additionally, there was a significant positive path from cannabis use at T2 to SOC at T3. No other paths were significant.

4. Discussion

One objective of the present research was to examine mutual influences between substance use and sense of coherence (SOC). Whereas individual differences in SOC appeared moderately stable (cf. Honkinen et al., 2008, 2009), our analysis revealed very little mutual influence between SOC and substance use. With only one significant negative longitudinal path from SOC to later cannabis use, for the most part, changes in SOC did not predict changes in substance use. Notably, even while controlling for preexisting correlations between cannabis use and SOC as well as for the respective autocorrelations of the two variables, at this young age SOC was still a significant predictor of cannabis use two years later. This hints at a possible causal protective influence of salute-genic resources for later frequency of cannabis consumption.

Regarding the mutability of SOC as an orientation-to-life, supposedly forming under situational and contextual forces, there was only one significant path from cannabis use to later SOC, where SOC was influenced by any substance use. This path in fact had a positive regression weight, that is, an increase in substance use predicted an increase in SOC. This pattern may support the hypothesis that dealing with substance use may – at the same time – represent successful dealing with developmental tasks (Silbereisen et al., 1987). More research seems necessary whether it is actually the successful completion of developmental challenges that fosters such an increase.

Taken together, the previously documented associations between SOC and substance use emerged, yet SOC, by and large, appears to exist or develop rather independently from substance use. This is rather surprising, considering the presumed mutability of SOC in adolescence and the significant role that the consumption of psychoactive substances plays at this age (Young et al., 2002). According to theory, SOC develops throughout adolescence and early adulthood, shaped by interpersonal relationships and personal experiences, until it stabilizes around the age of 30 (Antonovsky, 1987). Hence, our results are not in line with Antonovsky's conception of SOC being an externally shaped orientation to life rather than a temperamental personality trait. The lack of mutual influences between SOC and substance use, may in fact be due to SOC resembling emotional stability. Considerable overlap between SOC and Neuroticism has been reported before (Feldt, Metsäpelto, Kinnunen, & Pulkkinen, 2007; Hochwälder, 2012). However, as our

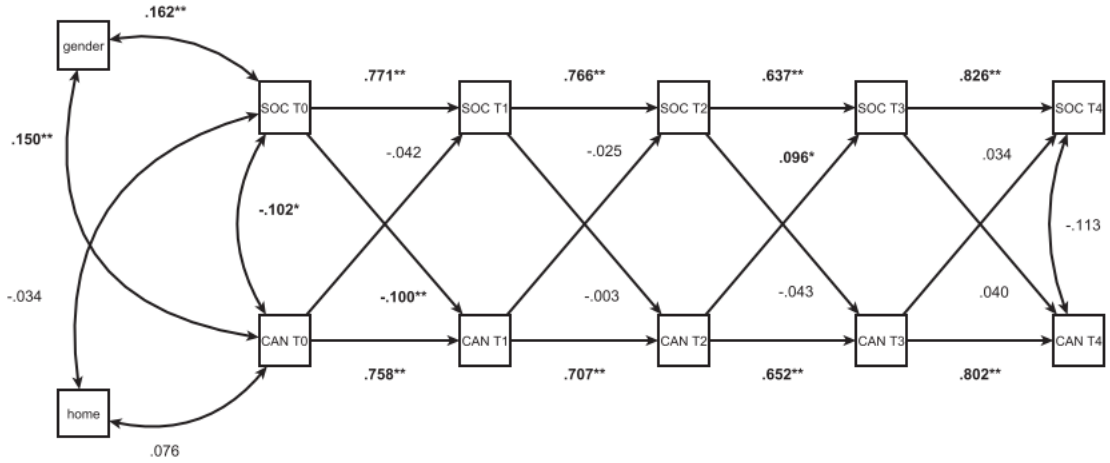

Fig. 4. Cross-lagged panel design for sense of coherence (SOC) and cannabis use frequency (CAN) with covariates gender and home (traditional family setting). Paths are significant at *p < .05 and **p < .01 (two-tailed).

own data show, SOC contains unique variance that incrementally explains substance use over and above Neuroticism and other competing personality variables (Grevenstein, Bluemke, & Kroeninger-Jungaberle, 2014). Hence SOC cannot simply be equated with a positively framed (or reversed) version of Neuroticism. Rather the interplay between flexible and stable aspects of SOC and their relationships to Neuroticism remain research topics for future investigations.

4.1. Limitations

As our sample size was just sufficiently large enough for structural equation modeling, it was necessary to aggregate data collection events over time. While possibly even increasing the reliability of the findings, this approach may have masked short-term changes. We also documented hints at systematic dropout from the study. Participants who dropped out consumed more tobacco and cannabis at age 14–15. As both models for tobacco use and cannabis use are the ones with most significant paths, this seems only a minor issue, but dropout may imply underestimated variance towards the end of the study. This potentially masked mutual influences that would have emerged if the whole spectrum of individuals had been analyzed. Still, at earlier time points, with less sample attrition, there were little signs for mutual influences.

4.2. Future research

Given some positive influence from substance use to later SOC, researchers may further look into certain forms of substance use as a way of coping with developmental tasks and its influence on the development of identity and personality. Furthermore, as substance use is in many ways gender specific (Chen & Jacobson, 2012), and given that gender differences were evident in our sample, the future use of multigroup SEM with larger samples might help to investigate gender-specific hypotheses.

Finally, we assessed substance use by means of a frequency measure. While frequency of substance consumption has been documented as a good predictor of health related outcomes (Young et al., 2002), it does not allow us to discriminate between adolescents' perception of their substance use as normative, damaging, helpful, or of little consequence. The motivations behind substance use and the perceived effects cannot be uncovered by frequency scales. As such, consumption may or may not be problematic, yet in a transitional phase it may simply reflect normative behavior among peers. Successful coping with this challenge might teach one a lot, contributing to positive personality changes; at least in retrospect such a phase might count as valuable aspect in life (Mezquita, Stewart, & Ruipérez, 2010).

4.3. Conclusions

The present research examined mutual influence between substance use and SOC. So far the evidence for this relationship has been inconclusive. Our findings clearly show that, in absolute terms, both SOC and substance use change throughout adolescence. Yet, neither do individual changes in SOC correspond to altered consumption patterns, nor does individual substance use impair the natural development of one's salutogenic resources, as would be implied by salutogenic theory. Our results indicated that SOC develops by and large independently from substance use. Given the overall association of high SOC with less substance use, SOC is a reasonable general predictor, and individual differences in SOC at early adolescence are already quite revealing. Yet, with some notable exceptions, SOC is not shaped by substance use.

Declaration of interest

The authors declare that they have no conflict of interest.

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